

*Sub
a/b
10*

determining whether to prefetch one or more of said Internet resources in said subset of Internet resources based on predefined conditions, at least one of said predefined conditions being based on said estimated round trip time.

REMARKS

This Amendment is submitted in response to the outstanding Office Action, dated

5 September 12, 2001, and is accompanied by a petition and fee for extension of time (one-month). Claims 1 through 29 are presently pending in the above-identified patent application. Independent claims 1, 17, 25 and 27-29 have been amended. No additional fee is due.

The present invention is directed to methods and apparatus for prefetching Internet resources based on the estimated round trip time for the resources referenced in a currently displayed 10 Web page. Documents with the longest access times are prefetched first and prefetching generally continues until the estimated round trip time falls below a predefined threshold. Thus, if a user clicks on an embedded hyperlink, the referenced document has either been fetched already or, if not, fetching the document from the origin server takes only a short time.

The “round trip” time or access time of a resource is the time interval between the 15 sending of the first byte of an HTTP request for the resource until the last byte of the server response has arrived at the requesting Web client. The round trip time may be estimated in accordance with the present invention, for example, using an HTTP HEAD request. A HEAD request obtains status information and the size of the requested resource, s , from the origin server. If the server responds to the HEAD request with the document size, s , the prefetching agent computes the estimated round 20 trip time for further processing. If the server responds but fails to specify the document size, the prefetching agent utilizes the recorded average resource size, s , of resources previously received from the server. If the HEAD request does not yield any response from the server, or if the response shows an error code, then the prefetching agent determines that the hyperlinked document is not accessible and can provide an error message immediately once the user clicks on this hyperlink.

25 In the Office Action, the Examiner has rejected claims 1 through 29 under 35 U.S.C. §103(a) as being unpatentable over Kunkel et al. (United States Patent Number 5,961,603) in view of

Vaid et al. (United States Patent Number 6,119,235). The Examiner asserts that Kunkel discloses the prefetching of Internet resources. The Examiner recognizes, however, the Kunkel does not disclose or suggest the prefetching of data based on round trip times and data size.

The Examiner further asserts that Vaid teaches a system to schedule downloading of data in order to provide optimized computer usage. In addition, the Examiner notes that Vaid teaches "estimating a bit rate over a round-trip time between the data source and the data receiver." *citing Abstract.*

While Vaid may disclose the estimation of round-trip times of data exchanged between a sender and a receiver in a data network, Vaid estimates the round-trip times of *TCP/IP packets.* The present invention, on the other hand, estimates the round-trip times of *HTTP request/response events.*

HTTP traffic travels through software that runs atop TCP/IP stacks on client, server, and proxy computers. HTTP traffic therefore incurs latencies caused by such software. These latencies are generally not reflected in the TCP/IP round-trip times computed by Vaid. Moreover, HTTP traffic for the purpose of Web document prefetching, as in the context of the present invention, shows characteristics in terms of length and origin server access frequency that general TCP/IP traffic does not exhibit (the origin server is referred to as the "receiver" in Vaid). The present invention takes advantage of such HTTP traffic characteristics in its round-trip time estimation.

For example, the present invention considers the length of an HTTP response (e.g., via an HTTP HEAD request) and the actually measured round-trip times of previous HTTP requests to the same origin server when computing the estimated round-trip time of an HTTP request/response event. Thus, the round-trip time estimations of the present invention are dynamically adjusted, based on changing network and server conditions, because estimates are based on previously measured round-trip times of HTTP request/response events to the same origin server. The adaptation to changing actual round-trip times is effected by a linear weighing function that uses previous HTTP request/response events, if available, to the same origin server as data points. If there was no previous HTTP request/response event to the same origin server in the past, a baseline estimate is established through actually fetching a document from the origin server via an HTTP GET request rather than estimating the round-trip time of the document. Vaid uses an unspecified

baseline estimate in all cases

Thus, Kunkel or Vaid, alone or in combination, do not disclose or suggest prefetching one or more Internet resources based on an estimated round trip time that is “based on an interval of time between a sending of an HTTP request and a receipt of a response to said HTTP request,” as required by each of the independent claims, as amended.

An example helps to illustrate the fundamental differences between Vaid and the present invention. Assume that a user, A, is communicating with two servers, B and C. The time interval between A sending a TCP packet to B and receiving back an acknowledgement is 100 msec. The time interval between A sending a TCP packet to C and receiving back an acknowledgement is 200 msec. Further assume that identical Web servers are added to both B and C and that B has a slower processor than C. An HTTP request for a resource, R, processed by the Web server on machine B takes 400 msec, whereas processing an HTTP request for a resource, R', by the Web server on C takes 100 ms. It is assumed that the HTTP requests for R and R' and the HTTP responses to R and R' all fit in one TCP/IP packet each, a quite typical scenario.

Thus, the estimated round trip time for sending the HTTP request for resource, R, from machine A to B (100 msec), processing the request in B's HTTP server (400 msec), and sending the HTTP response back to A (100 msec) is a total of 600 msec. The estimated round trip time for sending the HTTP request for resource, R', from machine A to C (200 msec), having C's HTTP server process the request (100 msec) and sending the response back to A (200 msec) is a total of 500 msec.

Thus, based on the TCP round trip time computed by Vaid, the resource from server C (with the longer TCP time) would be prefetched first. Based on the estimated round trip time computed by the present invention, however, the resource from server B (with the longer estimated HTTP round trip time) would be prefetched first. Thus, applying the present invention to this example yields exactly the opposite result that would be achieved using the round trip time of Vaid. However, Applicant asserts that this inventive method results in a more responsive and enjoyable user experience with reduced latencies in obtaining requested Web resources.

Dependent Claims 2-16, 18-24 and 26 were also rejected under 35 U.S.C. §103(a) as being unpatentable over Kunkel in view of Vaid. Claims 2-16, 18-24 and 26 are dependent on Claims 1, 17 or 25, respectively, and are therefore patentably distinguished over Kunkel or Vaid

(alone or in any combination) because of their dependency from amended independent Claims 1, 17 or 25, for the reasons set forth above, as well as other elements these claims add in combination to their base claim.

In view of the foregoing, the invention, as claimed in Claims 1 through 29, cannot be
5 said to be either taught or suggested by Kunkel or Vaid (alone or in any combination). Accordingly, applicant respectfully requests that the rejection of claims 1 through 29 under 35 U.S.C. § 103(a) be withdrawn.

All of the pending claims, i.e., claims 1 through 29, are in condition for allowance and such favorable action is earnestly solicited.

10 If any outstanding issues remain, or if the Examiner has any further suggestions for expediting allowance of this application, the Examiner is invited to contact the undersigned at the telephone number indicated below.

The Examiner's attention to this matter is appreciated.

15 Respectfully,

Kevin M. Mason

Kevin M. Mason
Attorney for Applicant(s)
Reg. No. 36,597
20 Ryan, Mason & Lewis, LLP
1300 Post Road, Suite 205
Fairfield, CT 06430
(203) 255-6560

Date: January 11, 2002

20

VERSION MARKED TO SHOW ALL CHANGES

1 1. (Amended) A method of prefetching one or more Internet resources referenced
2 in one or more Web pages, said method comprising the steps of:

3 obtaining an estimated round trip time for said Internet resources, wherein said
4 estimated round trip time is based on an interval of time between a sending of an HTTP request
5 and a receipt of a response to said HTTP request; and

6 prefetching said Internet resources based on said estimated round trip time.

1 2. (Unchanged) The method according to claim 1, wherein two or more of said
2 Internet resources are prefetched substantially in parallel.

1 3. (Unchanged) The method according to claim 1, wherein said step of
2 prefetching said Internet resources based on said estimated round trip time is performed only for
3 Internet resources associated with origin servers that have been previously accessed and said
4 method further comprising the step of prefetching all Internet resources associated with servers
5 that have not been previously accessed.

1 4. (Unchanged) The method according to claim 1, wherein said estimated round
2 trip time for each Internet resource is based on average access time statistics for the
3 corresponding origin server and the actual size of said Internet resource when said actual size is
4 available.

1 5. (Unchanged) The method according to claim 4, wherein said estimated round
2 trip time for each Internet resource is based on average access time statistics for the
3 corresponding origin server and the average size of Internet resources provided by said origin
4 server if said origin server does not indicate said actual size.

1 6. (Unchanged) The method according to claim 4, wherein said estimated round
2 trip time for each Internet resource is based on average access time statistics for the

3 corresponding origin server and the average size of Internet resources provided by said origin
4 server if the setup and wait time for accessing said origin server is not significantly less than the
5 average round trip time for Internet resources obtained from said origin server.

1 7. (Unchanged) The method according to claim 1, wherein said estimated round
2 trip time is based on at least one actual prior round trip time for said Internet resource.

1 8. (Unchanged) The method according to claim 1, wherein said step of
2 prefetching said Internet resources does not begin until said one or more Web pages have been
3 fetched.

1 9. (Unchanged) The method according to claim 1, wherein said step of
2 prefetching said Internet resources continues until said Internet resources have been prefetched or
3 until a user selects a new Web page.

1 10. (Unchanged) The method according to claim 1, further comprising the steps of
2 storing said Internet resources in a cache and determining if any of said Internet resources are
3 already stored in said cache before prefetching begins.

1 11. (Unchanged) The method according to claim 1, further comprising the step of
2 applying a filter to said Internet resources to reduce the overhead on network, server or local
3 resources due to prefetching.

1 12. (Unchanged) The method according to claim 11, wherein said filter discards
2 all Internet resources that do not use the HTTP protocol for transmission.

1 13. (Unchanged) The method according to claim 11, wherein said filter discards
2 all Internet resources that correspond to dynamically generated Web resources.

1 14. (Unchanged) The method according to claim 11, wherein said filter discards

2 all Internet resources that correspond to resources whose size is more than a certain maximum
3 size threshold.

1 15. (Unchanged) The method according to claim 11, wherein said filter discards
2 all Internet resources that correspond to resources whose estimated round trip time is longer than
3 a certain maximum time.

1 16. (Unchanged) The method according to claim 11, wherein said filter discards
2 all Internet resources that correspond to resources whose estimated round trip time is shorter than
3 a certain minimum time threshold.

1 17. (Amended) A method of prefetching one or more Internet resources referenced
2 in one or more Web pages, said method comprising the steps of:

3 determining an estimated round trip time for said Internet resources based on an
4 interval of time between a sending of an HTTP request and a receipt of a response to said HTTP
5 request;

6 sorting a list of said Internet resources based on said estimated round trip time;
7 prefetching said sorted list of Internet resources until one or more predefined
8 threshold conditions are met.

1 18. (Unchanged) The method according to claim 17, wherein two or more of said
2 Internet resources are prefetched substantially in parallel.

1 19. (Unchanged) The method according to claim 17, wherein said step of
2 prefetching said Internet resources based on said estimated round trip time is performed only for
3 resources associated with origin servers that have been previously accessed and said method
4 further comprising the step of prefetching all resources associated with servers that have not been
5 previously accessed.

1 20. (Unchanged) The method according to claim 17, wherein said estimated round

2 trip time for each Internet resource is based on average access time statistics for the
3 corresponding origin server and the actual size of said Internet resource when said actual size is
4 available.

1 21. (Unchanged) The method according to claim 20, wherein said estimated round
2 trip time for each Internet resource is based on average access time statistics for the
3 corresponding origin server and the average size of Internet resources provided by said origin
4 server if said origin server does not indicate said actual size.

1 22. (Unchanged) The method according to claim 20, wherein said estimated round
2 trip time for each Internet resource is based on average access time statistics for the
3 corresponding origin server and the average size of Internet resources provided by said origin
4 server if the setup and wait time for accessing said origin server is not significantly less than the
5 average round trip time for Internet resources obtained from said origin server.

1 23. (Unchanged) The method according to claim 20, further comprising the step
2 of applying a filter to said Internet resources to reduce the overhead on network, server or local
3 resources due to prefetching.

1 24. (Unchanged) The method according to claim 23, wherein said filter discards
2 all Internet resources selected from the set comprised substantially of those Internet resources
3 that (i) do not use the HTTP protocol for transmission; (ii) correspond to dynamically generated
4 Web resources; (iii) correspond to resources whose size is more than a certain maximum size
5 threshold, (iv) correspond to resources whose estimated round trip time is longer than a certain
6 maximum time, or (v) correspond to resources whose estimated round trip time is shorter than a
7 certain minimum time threshold.

1 25. (Amended) A system for prefetching one or more Internet resources
2 referenced in one or more Web pages, each of said Internet resources having an associated origin
3 server, said tool comprising:

4 a memory for storing a server statistics database that records access time statistics
5 for each origin server that has been previously accessed;
6 a processor operatively coupled to said memory, said processor configured to:
7 obtain an estimated round trip time for said Internet resources, wherein said
8 estimated round trip time is based on an interval of time between a sending of an HTTP request
9 and a receipt of a response to said HTTP request; and
10 prefetch said Internet resources based on said estimated round trip time.

1 26. (Unchanged) The system according to claim 25, wherein said server statistics
2 database records the average setup, wait and byte transmission times and average resource size
3 for said Internet resources obtained from said corresponding origin server.

1 27. (Amended) A method of prefetching one or more Internet resources referenced
2 in one or more Web pages, said method comprising the steps of:
3 determining if one or more of said Internet resources are candidates for
4 prefetching based on an estimated round trip time, wherein said estimated round trip time is
5 based on an interval of time between a sending of an HTTP request and a receipt of a response to
6 said HTTP request; and
7 prefetching said Internet resources that are determined to be candidates for
8 prefetching.

1 28. (Amended) An article of manufacture for prefetching one or more Internet
2 resources referenced in one or more Web pages, said article of manufacture comprising:
3 a computer readable medium having computer readable program code means
4 embodied thereon, said computer readable program code means comprising program code means for
5 causing a computer to:
6 obtain an estimated round trip time for said Internet resources, wherein said
7 estimated round trip time is based on an interval of time between a sending of an HTTP request
8 and a receipt of a response to said HTTP request; and
9 prefetch said Internet resources based on said estimated round trip time.

1 29. (Amended) A method of prefetching one or more Internet resources referenced
2 in one or more Web pages, said method comprising the steps of:

3 obtaining an estimated round trip time for said Internet resources, wherein said
4 estimated round trip time is based on an interval of time between a sending of an HTTP request
5 and a receipt of a response to said HTTP request;

6 identifying a subset of said Internet resources that are candidates for prefetching
7 based on said estimated round trip time; and

8 determining whether to prefetch one or more of said Internet resources in said
9 subset of Internet resources based on predefined conditions, at least one of said predefined
10 conditions being based on said estimated round trip time.